Digitized by the Internet Archive
in 2009 with funding from
University of Toronto

http://www.archive.org/details/n05radium04came

RM
859
R313
v. 4
no. 5
c. 1
GERSTS

RADIUM

EDITED BY
CHARLES H. VIOL, Ph. D.
AND
WILLIAM H. CAMERON, M. D.

VOL. IV FEBRUARY, 1915 No. 5

CONTENTS

Cancer of the Uterus and Radium: Clinical and Histological Considerations. By MM. Drs. P. Degrais and Anselme Bellot, of the Biological Radium Laboratory, Paris. (Edited and arranged by Dr. W. H. B. Aikins, Toronto.) - - - - - - - - - 81

The Influence of Radioactive Earth on Plant Growth and Crop Production, II By H. H. Rusby, M. D. - - - - - 94

Notes and Comments - - - - - - - - 104

LIBRARY
NOV 1 3 2001
UNIVERSITY OF TORONTO
THE PROPERTY OF
ACADEMY OF MEDICINE,
13 QUEEN'S PARK

A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES

RADIUM

A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY, PHYSICS AND THERAPEUTICS OF RADIUM AND RADIO-ACTIVE SUBSTANCES.

Edited and Published by Charles H. Viol, Ph. D. and William H. Cameron, M. D., with the assistance of collaborators working in the fields of Radiochemistry, Radioactivity and Radiumtherapy.

Subscription $2.50 per year, or 25 cents per copy in the United States and Canada; in all other countries $3.75 per year.

Address all communications to the Editors, Forbes and Meyran Avenues, Pittsburgh, Pa.

VOL. IV FEBRUARY, 1915 No. 5

CANCER OF THE UTERUS AND RADIUM:

CLINICAL AND HISTOLOGICAL CONSIDERATIONS.

BY MM. DRS. P. DEGRAIS AND ANSELME BELLOT,
Of the Biological Radium Laboratory, Paris.
(Edited and Arranged by DR. W. H. B. AIKINS, TORONTO.)

The histological modifications observed in the cancer cell under the influence of radium rays, and the clinical results obtained since 1905 in superficial cancer, gave *Wickham* and the writers of the present paper early encouragement to extend the sphere of radium therapy to deeply situated tumors, selecting in the first place those to which access was rendered comparatively easy by natural routes.†

The uterus above all was to benefit by the apparatus which has been devised for radium treatment, and the histological characteristics of the mucosa of the cervix uteri are such as to lead us to expect that it might, in a similar manner to the skin, respond very favorably to the action of radium.

We now propose to report in the first place the clinical results of our own personal experience, and to deal subsequently with the histological processes which govern the transformations

*Canadian Practitioner and Review. Vol. 39, No. 6, pp. 334-348, 1914.

†Wickham and Degrais: "Traite de Radiumtherapie," 1st edition, 1908. J. B. Bailliere, Editeur. "Radium et Cancer: Actualites Medicales, 1912," J. B. Bailliere, Editeur.

undergone by a cancer of the uterus when subjected to irradiation by the radium rays.

As regards the cases of epithelioma or sarcoma of the cervix which have come under our care, without being able as yet to specify which forms of growth are more amenable to radium than to surgery, or those in which the reverse obtains, it appears to us essential that we should place recurrences in a class by themselves. In this domain, when the patient is beyond the hope of relief from surgery, radium has enlightened by a new dawn the future of patients who are tortured by violent pain, and are destined to succumb rapidly from cachexia or exhaustion from profuse haemorrhage.

In order to substantiate the value of radium therapy, and to justify its pretensions to the important position which it has a right to claim, it is necessary only to show that in certain cases which are dependent upon surgery radium is equal or superior to it. We have to show that in desperate cases, in which only a few years ago the physician was reduced to those illusory therapeutics which are intended to impress the mentality of the patient, the appearance of radium has proved of great value to gynaecology.

In the hope of increasing the numbers of those to whom the recent acquisitions of science may be of service we have treated the patients referred to us as they happened to come, without excluding the most severe cases. *The satisfactory results obtained in the different groups of cases have led us to regard radium as a valuable therapeutic agent, which we are justified in placing in a similar category to the operative technique which has now been brought to such perfection. In a large number of cases it can with advantage supplement this technique, and is a valuable substitute for it in inoperable cases and recurrences.*

We will consider the action of radium successively in the following conditions:

1. Epithelioma of the cervix.
2. Sarcoma of the uterus.
3. Post-operative recurrences.

1. *Epithelioma of the Cervix.*—Although we are the first to recommend operation in cases coming directly to us in order to avoid it—our aim having always been to treat by preference cases in which surgery was powerless—we have treated some operable cases. We shall therefore have to consider:

(*a*) Operable Epithelioma of the Cervix.

(*b*) Inoperable Epithelioma of the Cervix.

(*a*) *Operable Epithelioma of the Cervix.—In this category surgery includes in its assets cases which have remained without recurrence for six and eight years; it is therefore logical to have recourse to it.* When radium can quote parallel remissions, of equally long duration and in as large numbers; then only will it be possible to choose between the two. At the present moment the number of patients in this group remains very small, and we do not, as a matter of fact, feel justified in resorting to radium treatment unless there are general reasons contra-indicating any

operation, or an absolute repugnance to any surgical intervention.

However this may be, we have had the opportunity of taking care of a sufficient number of patients to be able to quote a case which we have kept under observation for more than four years. The growth was a very circumscribed vegetating form of epithelioma, to which we applied flat radium apparatus, without any preliminary curettage of the neoplastic vegetations.

As a rule we prefer preliminary curettage, which moreover does not absolutely necessitate general anaesthesia. Curettage indicates in a more definite manner than digital palpation the points at which there is a tendency to epitheliomatous infiltration, the infiltration having already formed areas into which the curette penetrates with comparative ease. Such indications, which are valuable from the point of view of treatment, are equally so in regard to the future progress of the case, as they serve to direct attention to the points which ought particularly to be kept under observation.

The flat apparatus which was selected in the case above referred to adapts itself perfectly to lesions of the cervix, and it was easy to ascertain gradual subsidence of the cancerous vegetations, whilst the hæmhorrage and blood-stained discharge diminished in amount. At the same time the cervix diminished in volume, retraction of the vaginal culs-de-sac seeming likely to compress its last vestige. We have kept this patient under observation for more than four years, and her condition continues most satisfactory.

The results of radium applications appear to be identical in all these cases, with the exception that the sero-sanguineous oozing tends to disappear more rapidly in cases in which curettage of the neoplasm has been performed. The retraction of the vaginal culs-de-sac is always seen, and proceeds to such an extent as to enclose the very short stump, which is the last remnant of the cervix, at the end of a small tube in the form of a funnel, but the aspect of the cervix varies according to the severity of the cancerous disease, and in certain cases it really appears to have been amputated.

When, in certain very rare cases, pains exist, these rapidly disappear after the first applications, their disappearance coinciding with a very marked improvement in the general condition.

It seems to us that in cases in which there are all the indications of a veritable cure the patients should never be left without supervision, and that even in the presence of a result which appears definite it is a good plan to continue to subject the area to irradiation, with progressively longer intervals between the seances than those which were allowed at the beginning of the treatment.

(*b*) *Inoperable Epithelioma of the Cervix.*—It is very difficult to define the limits of operability, as these are not governed by absolute rules, and if we include in this category the cases to which we are about to refer it is because they have been sent to

us by surgeons who regarded them as inoperable.

The number of patients belonging to this second group is unfortunately very much larger than those in the first group, owing to the fact that cancer of the cervix frequently develops insidiously, and is not associated with pain from the time of its onset, this latter symptom often being the only one for which the patient consults a physician. Operable cancer is also much more frequently met with amongst the well-to-do classes than in the working classes, who are less likely to notice the slight abnormal symptoms which lead to the discovery of cancer at the period of onset.

Previous to the application of radium this group of patients remained outside the realm of active and efficacious therapeutics. There was in fact no method of treatment which claimed to have the power of directly influencing the cancer cell, and in our opinion the large number of inoperable cases which have been treated make it clearly apparent that it is possibly in this particular class of case that radium plays its most important role.

We do not wish at present to go so far as to speak of cure, as we believe that in spite of long years of remission the test of time has not yet been of sufficiently long duration for this. On the other hand, whilst fully recognizing that the results vary considerably in accordance with the variety of cancer, the extent of the lesions, and the severity of the general organic intoxication, *we are able to affirm that there has not been a single case in which the patient has not derived real benefit from the radium treatment.*

In fact, two of the symptoms, namely, pain and haemorrhage, are always favorably influenced, even when there is no hope of improvement of long duration, and in some cases, even the most severe, the patients remain to the end in a fairly comfortable condition, as the cachexia to which they succumb is due only to a general toxaemia, already of long standing. Disappearance of pain and arrest of haemorrhage restore the courage of the patient, and give her confidence in this appearance of cure.

In inoperable cases also we think it advisable to perform curettage before applying the radium, as this allows the rays to reach with more certainty the extreme limit of cancerous invasion. This especially applies to curettage of the cervix.

The local changes consist in arrest of the blood-stained discharge, which may be either spontaneous, or easily produced by digital palpation or examination by the speculum. The sanguineous discharge, diminishes in abundance, its fetidity disappears fairly rapidly, and in the course of a few days it is replaced by a serous discharge, which soon completely dries up.

There gradually takes place in the depths of the vagina a process of cicatricial repair, corresponding to a certain extent with the cicatrisation following total hysterectomy.

The improvement in the general condition is no less interesting, as it reflects the local modifications which are produced when a necessary dose of radium has been absorbed by the neo-

plastic tissues. The pathognomonic symptom complex, consisting of loss of appetite, emaciation and pale yellow color of the skin, disappears *pari passu* with the local improvement, and in some cases a veritable resurrection has been observed.

Before formulating, however, the truly surprising results which we have observed in cases which are amenable to radium, it is necessary to make a very sharp distinction, from the point of view of progonsis, between infiltrating and vegetating forms of cancer. Although these latter cases experience rapid transformation, it happens fairly often that the former are the site of infiltration, which is already very deep, and that they are already associated with remote metastasis. Radium is therefore unable to influence the more distant parts, and in consequence the results are as a rule much less satisfactory. It is necessary by every means in our power to irradiate in as complete a manner as possible every diseased point, in order to avoid leaving cells which have not been irradiated, or have been insufficiently irradiated, and are therefore capable of renewed proliferation. With this object in view we have in many cases, according to the extent of the lesions, considered it desirable to irradiate, not only the vagina and the cervical cavity, but also the rectum. This has rendered it possible to irradiate the recto-vaginal septum, which is too often the seat of cancerous invasion. Irradiation of the iliac fossae may also be useful.

We do not desire now to refer to cases which have been very recently treated, but thanks to this technique, it is possible for us to report cases which we have been able to keep under observation for periods extending over two, three and four years, the patients being at the present time in a state of health which promises well for the future. However, we examine them repeatedly, and in certain cases we have renewed the applications when it might be thought unnecessary to do so. This applies to a patient whose case we reported in our Treatise on Radium Therapy.‡

Unfortunately the results have not been so satisfactory in all the cases, for in certain patients, in spite of the favorable outlook of a first course of treatment by radium, there were subsequent recurrences which proved absolutely refractory to it, the cancer cell appearing to have organized itself to resist the disturbances produced by the first contact with radium.

Sarcoma of the Uterus.—We have had the opportunity of treating two cases of sarcoma of the uterus, and the results obtained deserve to be reported.

The first case was that of a woman 52 years of age. After a normal menopause she had a viscous and blood-staind discharge, the uterus being slightly increased in volume. On examination by the speculum the cervix was apparently normal, with the exception that the orifice was slightly open and a little fungoid. Histological examination of fragments removed by curettage showed sarcomatous tissue with small spindle cells, and numer-

‡Wickham and Degrais: "Traite de Radiumtherapie," 2nd Edit. Bailliere, 1913, p. 209.

ous karyokinetic figures. The patient was referred to us for treatment by radium, and we proceeded to make applications within the cavity, with alternate irradiation of all the culs-de-sac. Pain gradually disappeared, hæmorrhage was arrested, and at the present time, nearly a year after the beginning of treatment, there appears to be no longer any trace of the disease.

The second case was referred to us under entirely different conditions, as the lesion had developed more than three years previously in a young woman. A large mass occupied the left iliac fossa, and produced severe pain in that region, together with marked disturbance of the functions of the large intestine. Menstruation was extremely profuse. The uterus was increased in size; the vaginal culs-de-sac had lost all their flexibility, and were folded in a hard mass, which was firmly adherent to the true pelvis. The lateral left cul-de-sac and the recto-vaginal cul-de-sac were lined by papillomatous proliferation.

The case was regarded as hopeless, but, as frequently happens, the circumstances were such that to refuse all treatment would have been equivalent to signing a sentence of death. We therefore undertook the treatment under this hopeless impression, and with the feeling that our hands had been forced. We do not now regret that we did so, as intense irradiation of the left iliac fossa has led to reduction in volume of the mass situated in that region, to disappearance of the pain, and marked relief of the intestinal disturbance. Irradiation of the uterine cavity has rendered menstruation normal, and that of the culs-de-sac has diminished the amount of hæmorrhage, the characteristics of the discharge having become much less disagreeable to the patient. This case is still much too recent for us to attach any great importance to it, but even if all that has been done is the encouragement temporarily given to the patient we shall feel that by means of radium treatment we have rendered her a service which no other therapeutic measure which is known at the present time would have been capable of.

Post-operative Recurrences—There now remains for us to consider the treatment of recurrences, *in which radium plays without dispute a role which has created for it a unique position.*

These cases, whatever their manifestations, can hope for no more from surgery, and therefore fall into the domain of radium. From the point of view of what may be expected from radium treatment they may be divided into two very definite classes according to the characteristics of the recurrence. This may take place in the form of projecting hard masses, developing so to speak behind the vaginal curtain, but as the true pelvis subsequently becomes too small to contain them they gradually occupy the vaginal cavity. The only symptom is pain, and though radium may act in distintegrating the masses which are most accessible to the rays, and in considerably relieving the pain, we do not succeed in such cases in obtaining the remissions of long dura-

tion which are sometimes observed in the other form of recurrence.

The second variety of recurrence takes place in the vaginal cicatrix, and may manifest itself by pains, which, however, do not compare with those which the patients experience in the other form of recurrence. The characteristic symptom is discharge, which is in the first place serous, then blood-stained and sometimes sanguineous. This reappears, and attracts the attention of the patient.

It is in a form similar to this that we have had the opportunity of observing a case, which is possibly the most impressive, which is at the present time actually under the influence of radium. The case is that of a woman aged 48, in whom a histological examination made in 1907 led to a diagnosis of epithelial neoplasm of the uterus, for which hysterectomy was decided upon. In June, 1908, there was a recurrence in the vaginal cicatrix, and radium treatment was recommended. During the next seven months the applications were made very regularly, and since then at less frequent intervals. At the present time, six years after the commencement of the treatment, the patient is in a most satisfactory local and general condition.

In a subsequent paper we shall discuss the histological appearances and general considerations.

Histological Considerations.

A combination of such marked clinical results allows of the assumption of a special receptivity to the rays of radium on the part of the cancer cell, which has developed at the expense of the mucosa of the cervix uteri. The susceptibility is a real characteristic of it, but to what must it be attributed?

Without any reference to the power of action or of considerable penetration of the radium rays, a consideration of the histological structure of the mucosa of the cervix itself supplies us with an explanation. The histo-pathological characteristics of cancer of the cervix uteri are naturally of a similar type to those of the epithelial covering of this part of the organ. We are thus dealing with a neoplasm of the pavement type.

We do not propose here to enter into a detailed description of the various modifications of pavement epitheliomata, but will simply recall, for the sake of clearness of description, their principal distinctive characters.

Whilst in the *"typical"* lobulated form the *epithelial cells evolve to the adult stage after their normal process of keratinisation,* determining even the characteristic formation of the corneous globules, the *"metatypical"* epithelioma on the other hand differentiates itself *by an incomplete corneous evolution, which in many cases is absent altogether. The young cells which compose it, practically similar to those of the germinal layer,* are arranged in anastomosed tubes, separated by thin bands of connective tissue.

Between these two varieties of epitheliomata, namely, pure typical and pure metatypical epitheliomata, is a whole series of intermediate forms, tubulo-lobulated, with keratinization at dif-

ferent stages of evolution, manifesting itself only in a few cells remote from one another, or even in one portion only of the cell. (*Menetrier.*)

The *"atypical"* form is clearly distinguished from the preceding forms. *It is composed of polyhedral masses of atypical epithelial cells, very active in reproduction,* and separated by bands of connectivo-muscular tissue. Corneous formations are constantly absent in this form of epithelioma.

Although the typical form of these three varieties is very frequently observed on the surface of the cutaneous covering it does not appear that this applies to epithelioma of the cervix uteri. *Our histological examinations have most often revealed pure metatypical or parametatypical forms. The typical and* atypical forms both occur in a much smaller proportion of cases, especially as regards the pure typical variety.

This observation moreover, should not excite any surprise. The pavement covering of the cervix uteri, which belongs to a mucosa, does not experience the same evolution as the cutaneous epithelium. As it is not compelled to adapt itself to so important a protective function as that which is incumbent upon that of the integument it does not undergo the process of keratinization. We are therefore dealing with an incomplete and abnormal evolution, as compared with that experienced by the cutaneous epithelium, but it is at the same time none the less normal in so far as it concerns the mucosa, properly speaking, of the cervix uteri. Consequently and logically the metatpyical cancer of the cervix uteri is *" metatypical"* only by comparison with the typical pavement epithelioma of the cutaneous covering, but taken by itself, *given the histological constitution of the mucosa at the expense of which it develops*, it may be regarded as *"typical."* As to the presence of perfect or imperfect corneous formations, which has been observed in certain cases, it is explained by the fact that a few cells, in spite of adaptation to the epithelial medium from which they have originated, have pursued their evolution according to the process which is allied to the function which is originally incumbent on pavement of epithelium.

If the histological nature of these neoplasms of the cervix explains the rapid growth which is so often observed clinically, it also explains their special susceptibility to the radium rays.

The cells of which they are composed are young. Endued with an intense reproductive energy, their morphology is practically similar to that of the cells of the germinal layer, and they are consequently badly differentiated. These histological characteristics explain the description of the metatypical type of pavement epithelioma as cancer with basal cells (*Krompecher* and *Darier*), or *Malpighian* embryonal carcinoma (*Fabre-Domergue*).

The extreme susceptibility of the young cells to the rays is an acquired character. It is upon this fact that *Bergonie* and *Tribondeau* have based their law of a conception so general, according to which the susceptibility of the cell is so much the greater:

(*a*) The more intense its reproductive activity.

(*b*) The more delay there is in its becoming karyokinetic,

that is to say the further it is from its adult stage.

(c) The less definitely fixed are its morphology and its functions.

All these conditions affect the epithelial elements of the metatypical or atypical cancer of the cervix uteri, conditions which *Regaud* and *Blanc* have defined in showing the special hypersusceptibility of the primary evolutionary stages of a cellular element.

The best control which we possess of these facts consists in the extreme susceptibility to the rays of the lymphoid cells for example. The startling results which we have obtained from radium in the treatment of lymphadenomata and leukæmic or aleukæmic splenomegaly are an obvious proof of this.§

Cancer of the cervix uteri therefore exhibits the requisite characteristic of a special susceptibility to radium, and this is fully borne out by our clinical observations.

By what process is its retrogression effected? It is of a similar nature to that which we have already observed and described in neoplasms of the *Malpighian* type.** After a latent period of about ten or twelve days the epitheliomatous cells hypertrophy, the nuclei of some of them become monstrous, vegetating, and often polylobar, whilst the protoplasm already shows definite eosinophilia. A certain number of cells undergo keratinization, hypertrophying considerably, and sometimes retaining their nuclei in accordance with an atypical process.

At a more advanced stage, at about the twentieth day, almost all the neoplastic nodules are transformed into a mass of keratinized debris, in the midst of which may be seen, in a proportion varying considerably according to the type of tumor, corneous lumps composed of voluminious cells, with or without nuclei. These various elements are broken up and distintegrated by vasculo-connective tissue vegetations, consisting of young fibroblasts, cells of the lymphatic type, and a large number of polynuclear neutrophiles, which accomplish their phagocytic function at the same time that cicatrization occurs at the expense of the hyperplastic and rejuvenated stroma of the tumor.

We show here four sections of an epithelioma of the cervix, in which we have followed the retrogressive process by means of a series of successive biopsies. In this case we were dealing with a pure metatypical pavement epithelioma, which is shown in Figure I, before the beginning of treatment.

§Wickham et Degrais: "Traite de Radiumtherapie," 2nd Edit. Bailliere, 1912.

"Traitment des Leucemies par le Radium."

Renon, Degrais, Thibaut: (Soc. de Biologie, May 3, 1913.)

Renon, Degrais, Dreyfus: Academie de Medicine, June 17, 1913). (Congres de Londres, Aug., 1913).

Renon, Degrais, Desbouis: (Soc. Med. des Hop., July 2, 1913. Nov. 26, 1913).

Renon, Degrais, Tournemelle: (Soc. Med. des Hop., March 20, 1914).

Quenu et Degrais: "Splenomegalie traitee par le Radium." Soc. de Chirurgie, Nov. 12, 1913).

**Wickham et Degrais: "Traite de Radiumtherapie," 1912.

Wickham, Degrais et Bellot: "Modifications histologiques produites par les rayons sur les tissus sains et pathologiques." (Report at Fourth International Congress of Physico-therapy, Berlin, March, 1913.)

Section II represents a fragment of this same tumor removed ten days after the first application of radium. Whilst some of the cells have not yet undergone any transformation, others appear to have been practically destroyed by the rays, and already exhibit signs of necrosis. This shows itself by a retraction of the nucleus in pyknosis, or inversely by dispersion of the chromatic substance in the cytoplasm.

The most marked characteristic of this preparation, however, is hyperthrophy of the majority of the cellular elements, which in some of them attains quite extraordinary proportions, involving all the constituent parts of the cell. The nuclei are voluminous, irregular, budding, or hyper or hypo-chromatic, and a few of them are monstrous. The protoplasm, instead of being purely basophile, tends towards acidophilia.

In Section No. III, obtained from a biopsy made on the twenty-ninth day, we observe the disappearance of the neoplastic cells and the commencement of the phenomena of cicatrization. In the right superior angle of the preparation we find a group of hypertrophied cells at a very advanced stage of necrosis. They are in a state of karyolysis and cytolysis, and are surrounded and infiltrated by numerous young and polynuclear cells, which, after breaking up and distintegrating them, will accomplish their phagocytic function.

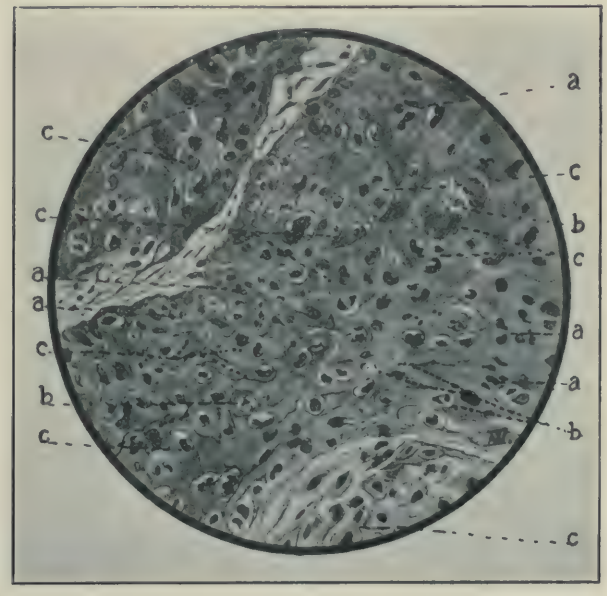
The median zone of the preparation shows us this process of distintegration at the stage nearest to cicatrization. The vestiges of a few degenerated epitheliomatous cellular elements are seen in the meshes of a collagen. This collagenous recticulum is rich in elements originating from the hyperplastic and rejuvenated stroma of the tumor, cells of the lympho-connective tissue type, young fibroblasts, and plasma cells, the evolution and organization of which will gradually result in definite, cicatrization. Mononuclear and polynuclear cells are also present.

Preparation No. IV comes from a biopsy practised at the site of the cervical cicatrix three months after the first application of radium. The hyperplastic stroma seen in the previous section has given place to fairly dense connective tissue, rich in cellular elements. A few beautiful stellate connective tissue cells, and some capillaries of recent formation, adorn the cicatricial tissue, in the depths of which traces of tumor cells can no longer be found.

We may add that the patient, in whom this histological examination was made, and who presented an inoperable form of cancer of the cervix, has remained for eight months in the most satisfactory general and local condition.

General Considerations.—Upon the results obtained in operable cancer of the cervix and in recurrences, and upon the indubitable proofs of the action of radium upon the cancer cell, *it appears to us legitimate to base the adoption, as a routine procedure, of vaginal irradiation after every ablation of the cancerous uterus.* It also seems to us that in surgical technique, as for instance after the removal of the breasts, we should not deprive ourselves of the resources of radium, which is capable of trans-

Section No. I. Metatypical Pavement Epithelioma of the cervix uteri.— Before treatment. (Gr. 180 D.)

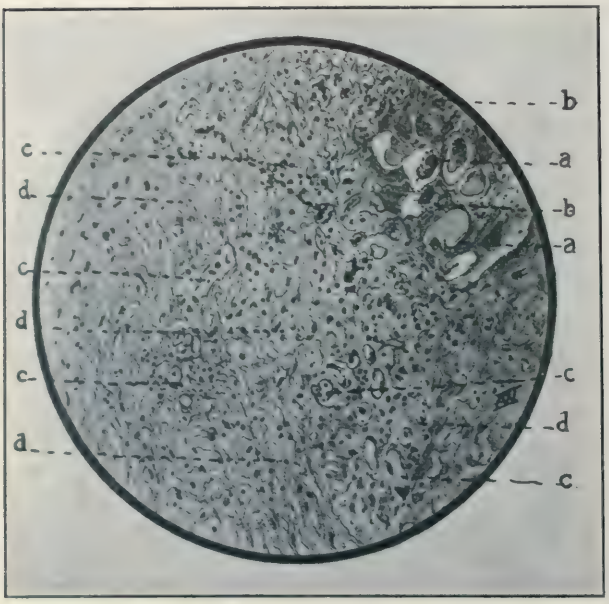


Section No. II. Same Epithelioma. Fragment removed 10 days after the first application. (Gr. 180 D.)

(a) Cells which have not yet experienced any modification.

(b) Cells affected by the rays, and already showing signs of necrosis, (retracted nucleus in pyknosis, or chromatic substance dispersed in cytoplasm).

(c) Cells hypertrophied to a variable extent, with irregular nuclei, (often monstrous and budding).



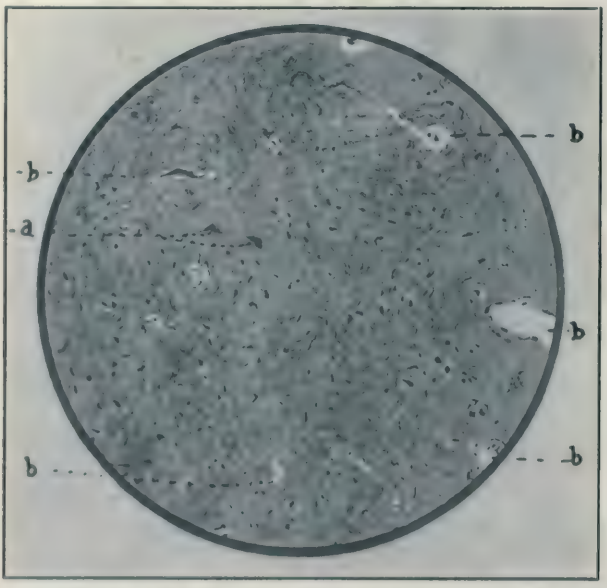
Section No. III. Same Epithelioma. Biopsy made on the 29th day. (Gr. 180 D.)

(a) Group of degenerated hypertrophied epitheliomatous cells; disappearing; (karyolysis, plasmolysis, cytolysis) surrounded and infiltrated by:

(b) Embryonal and polynuclear cells.

(c) Necrotic cellular remanants invaded by polynuclears; which disintegrate them; phagocytosis. Young connective tissue.

(d) Rich in embryonal cells, fibroblasts, plasma cells, origin of definite cicatrisation; occupies the greater part of preparation.



Section No. IV. Same Epithelioma. Fragment removed at site of cervical cicatrix 3 months after first applications of radium. Dense connective tissue, rich in cellular elements.

(a) Beautiful stellate connective tissue cells.

(b) Capillaries of recent formation.

forming beneficially an area in which some cellular remnants might induce an unfortunate recurrence of the neoplasm.

Radium is likely to play its role so much the better, the more the neoplasm has been reduced to an appreciable minimum by a surgical operation. We may say also that the *latter may be facilitated or even rendered possible by radium, which, in certain cases, modifies an inoperable neoplasm to such an extent that it becomes operable.* Such cases, above all others, would be amenable to post-operative irradiation.

In spite of our long period of personal practice we have been unable to formulate any statistics, owing to the fact that the cases differ so much from one another, and we can here give only a general summary of facts reflecting the general impression which has been made upon us by the numerous cases of cancer of the uterus or of recurrence which we have treated by radium.

Excluding cases in which the lesions have deeply invaded the true pelvis and the ganglia, and those in which extension to the bladder and rectum render any attempt at complete treatment of the neoplasm impossible, it may be said that the distressing symptoms and hæmorrhage have invariably been greatly relieved by the application of radium.

Although we emphasize the value of radium therapy, we do not for a moment intend to claim that radium plays the role in the cure of cancer. Our present object is to render obvious its value as a new therapeutic agent, which is capable of rendering services to the patient, such as can be rendered by no other method of treatment, excepting always those which can be rendered by surgery in operable cases.

Without wishing to revert here to the special practical facilities of the armamentarium of radium therapy, we think it desirable, whilst doing justice to the painlessness of the applications, to point out a few manifestations inherent in the treatment, which it is essential to recognize and take into consideration. Even during the applications the patients may experience a sensation of nausea, which in certain cases results in vomiting, but which otherwise disappears very rapidly.

During the following days the patients may complain of very marked prostration. It is advisable to warn them of this, in order that this symptom, which is moreover quite transitory in duration, should not discourage them in regard to the future. Finally, in ten to fifteen days after the applications there are symptoms of remote reaction, showing themselves on the part of the bladder and rectum by a frequent desire to micturate and defæcate, as well as by the emission of muco-membranes. These symptoms remain acute for eight to ten days, after which they disappear, leaving no trace.

In conclusion it may be said that although extraordinary retrogression and considerable prolongation of life have been observed, sometimes even in desperate and fatal cases, it is particularly essential, in dealing with this subject, to carefully weigh the reservations which *Wickham* and ourselves have always made in regard to cancer, and to consider the satisfactory results in cold blood.

We may add that the interest of radium treatment of cancer of the uterus, apart from the method of application, is dependent also in a marked degree on the utilization of the method of surgery-radium therapeutics. The role of radium is to frequently come to the assistance of surgery, immediately after curettage, partial extirpation of the uterus or total hysterectomy; or before operation with the object of rendering operable a tumor which is inoperable or can only be operated upon with difficulty.

In every way radium may intervene to relieve the patients and to prolong their existence under more tolerable conditions. This applies even to desperate cases, associated with repeated hæmorrhages or intolerable pain.

The Influence of Radioactive Earth on Plant Growth and Crop Production, II.*

By H. H. Rusby, M. D.,

Dean of the College of Pharmacy, Columbia University.

My experiments and observations included the winter culture of radishes in a market gardener's greenhouse, some seedlings in window boxes in my own home; field crops covering more than one hundred acres at Northfield, Ohio, under the direction of Mr. W. W. *Darley,* an experimental garden at Pittsburgh, and the plantation of an acre and a half at Nutley, N. J., of which I have had immediate personal charge throughout the season.

The greenhouse radishes were already about an inch high when the radium was applied. A furrow was scratched midway between the rows, which were four inches apart, and the powder sowed therein at the rate of sixteen grains to the square foot, which is equal to about fifty pounds to the acre. A square yard was thus treated and was compared with an exactly similar square yard upon the same bench, about ten feet distant. The radium radishes soon appeared much inferior to the others, and continued to do so to the end of the experiment, the tops being smaller, as though stunted, but on harvesting and weighing the green tops and the roots separately, the tops were found to weigh 17 per cent. less from the radium plot than from the other, while the radishes weighed about 20 per cent. more.

The season of growth had been very bad, February being very stormy, with little sunshine, and that little largely excluded by snow lying upon the glass roof. This observation is of much importance, indicating that it required less green leaf surface under deficient sunlight for the plant to manufacture a larger amount of food for deposit in its root. It will later be seen that various other experiments indicate and elucidate this principle.

*A lecture delivered at the New York Botanical Gardens, November 14, 1914.

For the grower of winter market produce under glass, who suffers from insufficient sunlight and is obliged to maintain a great amount of leaf-tissue in order to secure a moderate production of nutriment, the use of such a stimulating material will mean a huge economy.

Both of my window boxes were filled from the same pile of soil, similarly treated in every way except that in one the above-mentioned amount of radium earth was mixed through the soil. All operations were conducted for both boxes at the same time. Their positions in the window were exchanged from time to time, so as to preserve absolute equality of conditions. In the boxes I sowed cabbage and tomato seed in alternate rows. The seeds germinated one or two days earlier in the radium box and the plants were already well developed when those in the other box broke through the ground. The difference was more marked with the cabbages than with the tomatoes. The original lead of the radium plants continued to increase throughout the experiment, and after some two months, when the experiment was brought to a close, a given number of plants in the radium box would have weighed from six to ten times as much as from the other.

In Mr. *Flannery's* garden I particularly noted the great gain of turnips and beets under the radium influence over those without it. Radishes, which I did not myself see, were said to have yielded more than 100 per cent. increase under the radium treatment. The quality of the radium-grown vegetables was a matter of special comment by all who tried them, and this has proved true of all vegetables raised elsewhere under this treatment.

Operations at the Northfield farm were greatly handicapped by the heavy rains of March, April, and May, which delayed planting for more than a month beyond the proper time, and which later drowned portions of the crops in low places. Later severe drought caused further injury. Many of the results are, therefore, not yet available, but the growing crops, which I have observed with great care on various occasions, have shown results in all respects similar to, but greater than those recorded at my Nutley plantation, which I shall now describe.

The powdered radium ore tailings were applied to the land in the proportions of about 25, 50, 100, and 200 pounds, respectively, to the acre. This meant, on plots of 5 by 20 feet, only one, two, four, and eight ounces, amounts inconveniently small for uniform distribution. Therefore, to each such portion eight ounces of ordinary fertilizer was added and very thoroughly mixed by steam power. This mixture made of the tailings a sort of radio-active fertilizer, for which the symbol R. A. F. will here be used, although the figures stated will actually represent the amount of the tailings contained therein.

A field having an area of one and one-half acres was secured and surrounded by a high fence to prevent possible interference. Half of the ground formed a gentle slope to the east, the remainder occupying the level above. The ground was a light, decomposed sand-shale and was moderately stony. Through this plot, from east to west, was laid a road six feet in width. On one

side the strip was 114 feet wide, on the other 78 feet. The whole was divided into thirty-four sets, each set consisting of five plots.

One plot AA, was treated with R. A. F. at the rate of 200 pounds to the acre; another A, with 100 pounds; a third, B, with 50 pounds; C with 25 pounds, and X with none. Each set of plots was nineteen feet wide, and the plots composing the sets were, respectively, five, thirteen, nine, or twenty feet by nineteen feet, according to the nature of the crop. Each plot was separated from those on its four sides by paths three feet wide, except for the central road, which was six feet wide. As will be seen from what follows, this three feet was too narrow a separation to prevent the radium emanation from reaching every plot on the tract and modifying its yield.

Each plot of a series received exactly the same amount of the same kind of fertilizer, applied at the same time and in the same way. Every operation of seeding, hoeing, cultivating, etc., was performed across all five plots at once. Thus, if rain or other condition caused interruption, no plot would have any advantage or disadvantage as to time over the other. In short, absolutely no differences existed in the conditions affecting the growth of plants in the five plots of a series, except as to the amount of R. A. F. that was applied.

In all but one case, the R. A. F. was sowed equally over the surface and then dug in. In this one case, part of it was put in the rows, in order that a comparison of results might be obtained. When some of the early crops were harvested, the ground was again dug, and other crops planted. More fertilizer was then applied, but in no case was any more R. A. F. added. The R. A. F. in the soil was, however, much more thoroughly distributed by this second digging.

That the three-foot path was not sufficient to prevent the emanation from crossing and affecting the adjoining plots is fully proved by the observations which follow.

A 5 by 9-foot plot of turnips, not treated with radium, lying just north of one treated with 25 pounds R. A. F. to the acre and having the rows running north and south, shows the plants at the southern end of each row, and, therefore, separated by only the 3-foot path from the 25-pound plot, twice as large and strong as those at the northern ends. The graduation in size from the large to small plants, in all ten rows, is almost as regular as though produced mechanically. There is an exactly similar difference among the turnips in the 25-pound plot, those at the southern ends of the rows, separated by 3 feet from the 50-pound plot, being twice as large as those at the northern end, with the same regular gradation. Between the 50-pound and the 100-pound plots there is little difference, showing that 50-pounds produces about the maximum effect on turnips.

Between the 100- and the 200-pound plots, however, there is a similar but reversed relation. The turnips in the 200-pound plot are stunted by an excess of R. A. F., just as was the spinach that occupied the same plot in the early spring. Now, the plants in the 100-pound plot, lying across the path from the 200-pound plot, are similarly stunted, while their size increases regularly

from that side to the north side, where they are as large and fine as in the adjoining 50-pound plot. In the series of plots next to the west, the celery plants show exactly the same series of differences as do the turnips.

Had I performed no other experiments than these this year, I should have regarded the results as conclusive, since there is no other possible cause for the differences in the plants than the effects of the different amounts of R. A. F. It is in this way that I explain the wide difference in the extent of the gains by R. A. F. at the Northfield farm and those at Nutley. At Northfield the plots compared are acres in extent, so that the radioactivity from one could affect only a very narrow strip of the other, and the difference in weight of crops would show the full difference in activity of the radium. At Nutley, on the other hand, no plot, even though no R. A. F. was applied, was entirely free from radium influence, which increased its yield above the normal, and decreased the differences between it and the radium-treated crops. It has been suggested that the effects on the crops were due to the uranium present in the R. A. F. because of the very small amount of radium present. This is obviously impossible, since the uranium could affect only the plot in which it was placed. The only possible substance, the influence of which could cross the path to the neighboring plot is the radium emanation.

All these results are permanently and indisputably recorded by a series of photographs, which display with great accuracy minute differences between the respective plots.

In the accompanying table each plot is indicated by the number of pounds of R. A. F. that it received to the acre. It will be observed that no plot received less than twenty-five pounds, while at Northfield the plot with the least R. A. F., namely D, received twelve and a half pounds to the acre. On the other hand, none at Northfield received more than 100 pounds, (A), while at Nutley AA represents 200 pounds to the acre.

In several cases, a second crop was planted on plots from which the first crop was harvested early in the season.

Some of the facts indicated by these results will now be stated.

Nearly all, if not all field crops will give an increased yield under the influence of the proper amount of R. A. F. The largest gain recorded at Nutley was 129 per cent.

Probably the yield of all crops will be decreased if a sufficient excess is applied. In most of the cases, such excess is not reached by the 200 pounds R. A. F. to the acre, although in most cases the greatest gain is attained by a smaller amount.

The amount of radium required for the greatest results differs with different crops.

AA is best in five cases.

A is best in eight cases.

B is best in five cases.

C is best in eleven cases.

TABLE 1.—Showing pounds produced from plots

	AA, 200 Lbs. RAF to acre	A, 100 Lbs. RAF to acre.	B 50 Lbs. RAF to acre
LEGUMINOSAE			
Telephone peas	20.9	21.15	23.11
Nott's peas	13.11	16.	15.2
String beans	33.10	35.2	32.7
Lima beans	68.	92.	81.5
CHENOPODIACEAE			
Spinach	4.3	9.12	11.14
Beets	133.	132.	133.
SOLANACEAE			
Potatoes	48.	56.	65.
Early Tomatoes	181.	270.	309.
Late tomatoes	169.	226.	242.
Egg plants	160. (1.9) ea.	160. (1.7 ea.)	118. (1.7 ea.)
Early peppers	14.	28.	24.
Late peppers	18.5	16.	13.
CUCURBITACEAE			
Cucumbers	(8.15 (5 oz. ea.) (4.15 small	7.7 (3.8 oz. ea.) 5.8 small	9.12 (4.5 oz. ea) 4.14 Small
Pumpkins	277. (6.9 ea.)	243. (6.4 ea.)	321. (7.1 ea.)
Hubbard squash	185. (7.7 ea.)	232 (8. ea.)	150. (200) (6.8 ea.)
Watermelons	370. (19. ea.)	340. (9.75 ea.)	378. (11.33 ea.)
Delicious squash	217.	233.	226.
Hackensack melons	87.	103.	116.
Rocky Ford melons	39.	83.	72.
CRUCIFERAE			
Turnip radish	54.1	57.4	64.10
Long radish	.....	81.3	78.1
Early cabbage	384. (3.2 ea.)	412. (3.4 ea.)	388. (3.1 ea.)
Late cabbage	460. (4.8 ea.)	404. (4.6 ea.)	458. (4.7 ea.)
Flat turnips		15.	
Long turnips		32.	
GRAMINEAE			
Late corn	81. (0.55 ea.)	80. (0.6 ea.)	90. 0.56 ea.
Early corn	95. (6 oz. ea.)	92. (5.3 oz. ea.)	90. (5.7 oz. ea.)
UMBELLIFERAE			
Carrots	85.	104.	138.
Parsnips			
Celery			
LILIACEAE			
Onions	33.		
COMPOSITAE			
Lettuce	32.12	31.	26.12

variously treated at Nutley Plantation.

C, 25 Lbs. RAF to acre.	X, No. RAF	Per Cent. of Increase Over X				X Over Next Best
		AA	A	B	C	
19.4	22.			8.		
20.6	16.10				22.5	
30.14	31.11		11.			
93.	79.5				17.	
16.1	15.5				5.	
126	133.	All equal				
66.	61.				8.2	
293.	330.					7.
213.	267.					10.
120. (1.9 ea.)	153.	4.5	4.5			3.5
28.5	29.					
12.5	13.	42.				
10.1 (3.8 oz. ea.)	7.14 (4 oz. ea.)				35.7	
3.15 small	5.10 small				5.4 tot.	
222. (6. ea.)	206. (5.1 ea.)			56.		
100 (133)	161.5 (7.7 ea.)		44.			
(6.7 ea.)						
333. (8.12 ea.)	269. (8.25 ea.)			27.7		
258.	188.				35.5	
68.	73.			59.		
50.	46.		80.			
66.10	64.7				2.5	
70.5	58.		70.			
280. (3.3 ea.)	349. (4. ea.)		18.			
420. (4.3 ea.)	405. (4.4 ea.)	13.6				
	11.		36.			
	14.		129.			
95. (0.61 ea.)	63. (0.42 ea.)				50.	
95. (5.5 oz. ea.)	88. (5.5 oz.)	8.			8.	
118.	111.			24.		
	24.5	35.				
34.5	36.9				29.	

Families of plants show the same varying susceptibility. Members of the Cruciferae or mustard family, comprising mustard, rape, cabbage, cauliflower, sprouts, kale, kohl-rabi, turnips and radishes are greatly benefited. So are the Cucurbitaceae, comprising the pumpkin, cucumber, squash, and melons; in fact, more so than any others. The Gramineae or grass family, comprising hay, corn, sugar cane, sorghum and lawn grass, is enormously benefited. In this connection, it is to be noted that lawns are peculiarly benefited, because of the special activity of radium on young growing leaf tissue. It is also to be noted that all observers have remarked on the great effect in improving the showiness of flowers.

The effect upon germination, when small amounts are used, is to increase the percentage of seeds germinated and to accelerate the process.

The earliest effect of radium is to increase the root growth. Often the stem growth will be retarded for a time, but will later undergo a great acceleration.

A given amount of sunlight will produce a greater amount of growth when radium is used, and the same amount of food production will result from a smaller amount of green tissue, or tops.

Perhaps the most important effect of the radium is that of improving the edible properties of the products. Potatoes are more mealy. Root crops are remarkably tender, sweeter and of finer flavor. To so great an extent is this true that nearly every one who has used our radium-grown vegetables, to the number of scores of persons, have voluntarily commented upon the fact, and our own experience has fully confirmed the view. Beets, carrots, onions, sweet corn and similar vegetables are markedly sweeter. Radium-grown string beans and peas are peculiarly sweet and delicious.

My experiments indicate, besides the above, the following facts which cannot be asserted without further evidence.

My plots of lettuce, after being planted out, were visited by a severe frost which either immediately or very shortly caused the death of a number of them. The percentage of death in the several plots decreased with the amount of R. A. F. present.

The results of experiments with turnips are of greater interest and perhaps of greater importance than any others secured. Two varieties were planted, one the cowhorn, which produces a long slender root like a carrot, and the other the white globe, producing a short rounded root, half or more of it borne above the surface of the ground. These varieties were selected in order to ascertain whether the longer variety would show a greater effect from the action of the R. A. F., as I had previously found true of long radishes as compared with small round ones, in which case the latter showed only 2 or 3 per cent. increase over the control plot, while the former showed 70 per cent. in merchantable radishes and 40 per cent. in total.

In the case of the globe turnips I collected 11 pounds from the control plot and 15 pounds from the A plot, a gain for the latter of about 36 per cent. In the case of the long turnips, I harvested 14 pounds from the control plot and 32 from A, a gain

of about 129 per cent. These two instances go far towards indicating that the larger the amount of root buried in the soil, and thus exposed to the action of the emanation, the greater will be the gain in that crop. This result agrees with theoretical considerations. It has been established that the entire plant, and more especially the root, becomes radioactive and that this activity resides in the contained water, which would naturally impart a greater activity to that one with a larger root surface buried in the soil, where it can absorb the radioactive water, this water continuously stimulating all the cells with which it is in contact.

There are other interesting considerations in this case. The season of turnip growth, from late August to middle October, was this year marked by almost total absence of rain, so that the crop was practically a failure. At the time of collection, October 14, the foliage on the control plots was completely dead and dry. The C plot of cowhorn turnips was almost as bad, while the other three, especially the AA plot, were successively less damaged, having more or less green foliage and being still in a growing state. Therefore, had the time been extended, the percentage of gain over X would have been still greater than that now recorded. On the other hand, the conditions and the results are now abnormal, and we probably could not expect such large differences under ordinary conditions.

As to the round turnips, the same difference existed, although in somewhat lesser degree. This gain brings us to the consideration of the influence of radium upon the plant's resistance to drought. It indicates quite clearly that the effect of the radium is to increase such resistance. In the case of my egg plants, however, it appeared to decrease such resistance. The latter result appears somewhat contradictory of the effects upon the plant's resistance to frost. The injury to the plant, and the nature of such injury, from frost, is closely akin to that from drought, and as we have seen in the case of lettuce, radium appears to increase resistance to drought. It is possible that this discrepancy is due to the fact that the turnips continued to grow where the seeds germinated, while the egg plants, of rather large size, were attacked by drought just after they had been transplanted from the seed bed.

Some little light has been thrown upon the effects of radium upon plant diseases. The early part of the season was very wet, and the tendency to blight in cucumbers, squashes, and muskmelons, to smut in sweet corn, and to fruit rot in eggplants and tomatoes was rather marked. The damage in the radium-treated plots was not the same in the different crops. Cucumbers and squashes appeared to suffer most where there was most R. A. F., the melons where there was none. Early corn (Golden Bantam) suffered about twice as much from smut where there was most R. A. F. as where there was none, while late corn (Country Gentleman) showed little difference in the different plots.

This is probably the reason for the small percentage of increase in the crop of Golden Bantam as against 50 per cent. in-

crease in Country Gentleman, from the effects of the R. A. F. Had all smutted ears from the former been good, and therefore weighed with the others, the yield from the R. A. F. plots would have been much greater.

Tomatoes and eggplants suffered very little from rot on the heavily treated plots, but severely where there was little or no R. A. F. In the case of eggplants the ratio of damage on the different plots ran almost exactly the same, but inversely, with the amount of R. A. F. applied.

One of the most interesting observations referred to the activity of cut worms upon cabbage plants. Both early and late cabbages were heavily attacked by this pest, more especially the early ones. About a third of the plants were cut off in the control plot and almost as many in C. When replaced by new ones, many of the latter were again cut down. The B plot also lost quite a number, but the AA and A plots only one plant each. It did not appear to me possible that this difference was due to the presence of radium and I should scarcely have noted it but for the fact that a gentleman who had applied R. A. F. to his lawn in Virginia called to say that this was the only lawn in his neighborhood that had not suffered from cut worms, some having suffered so greatly as to be nearly destroyed. It will be very desirable to follow up these two cases with others and ascertain whether the R. A. F. is actually responsible for the protection observed.

The relative effects on the upper and lower portions of a sloping plot have not been uniform. Of ten rows of celery so planted, plants in the lower rows are nearly twice as large as those in the upper ones, and the transition is gradual and nearly equable. A possible explanation of this is by assuming that in case of a hard rain, with surface drainage, the emanation in the water in the soil would quickly diffuse through the surface water and be carried downward. In the case of egg plants there is an equal difference, but in favor of those in the upper rows. One might explain this by assuming that the emanation from the upper rows, which escape into the air, would pass over the surface of the ground in the lower rows. Their action upon the aerial tissues is relatively slight. Those from the lower rows would strike the roots of the plants in the upper rows. The explanations are mutually contradictory, but so are the effects observed in the two cases.

In conclusion, it may be stated that the yield of most crops can be increased by the addition of some amount of R. A. F., the amounts differing with different crops. The beneficial effects continue over successive crops, probably for many years. The largest amount required by any crop would cost less than the increased market value of such crop of the first year.

The most satisfactory results will be in greenhouses, in winter crops raised in the South, in the kitchen and flower gardens, and on the lawn . The quality of vegetables is improved even more than the yield. The grain will be largely increased where irrigation is possible.

Radium is not a plant food. The necessity for fertilizer is but little decreased by its use. The fertility of unused ground will spontaneously increase at a much greater rate when treated by radium.

Subjects worthy of investigation are the effects on yield of fruit trees and vines; the specific effects on plant diseases; the relative value of placing the R. A. F. in the rows or hills and of sowing it broadcast; the effects on the decomposition of organic matter in the soil; the influence of the different kinds of soil upon the result; the ultimate effects on the vitality and quality of crops raised from seeds successively produced for some years on radium treated soil; the influence on the medicinal strength of drug plants; the effects on crops not tested in my experiments, as flax, mustard, sweet potatoes, peanuts, cotton, tobacco, sugar cane, pieplant, alfalfa, etc.; specific effects on different flowers.

The results at the Weja (Northfield, O.) farm call for some special consideration. The soil here was of a totally different character from that at Nutley. The basic soil is a stiff clay, forming a deep, heavy, tenacious mud in very wet weather and baking rather hard during a drought. In the lower places this clay is overlaid by and more or less mixed with a large quantity of decayed vegetable matter, forming a black muck in rainy weather and a dry powdery mass during a drought.

Another important difference is that the R. A. F. as well as the fertilizer, was drilled in the rows or deposited in the hills, instead of being sown broadcast as at Nutley.

Finally, the plots were of large size, in no case smaller than one-twentieth of an acre and in some cases including several acres. In each case, the land was so selected that all the plots of one crop were approximately of the same character, and in all other respects the conditions were uniformly maintained for all five plots. Owing to one or more or all of these differences, the increases secured by the use of the R. A. F. were nearly double what they were at Nutley. There is, however, a general uniformity in the relative results on the several plots of any one crop. These results are displayed in the following table:

TABLE II.

Results at the Weja Farm.

Variety	Pounds R-A Earth Per Acre.	Per Cent. Gain Over Control.
Beans, Black String	25	27.1
Beans, Navy	25	14.0
Beans, Red Kidney	25	16.2
Beets, Garden	100	35.0
Beets, Mangel	100	21.0
Beets, Sugar	100	25.2
Brussels Sprouts	50	40.0
Cabbage, Early	50	68.0
Cabbage, Late	100	27.4
Carrots	50	16.5
Cauliflower	50	82.0
Corn, "Golden Bantam"	100	25.0
Corn, Field	50	27.8
Corn, "Country Gentleman"	50	46.0
Cucumbers	100	55.4
Hay, Timothy	100	35.0
Melons, Musk	50	69.0
Melons, Water	25	62.5

Oats	100	50.0
Onions	12.5	19.8
Peas, Early	100	51.7
Peas, Late	100	45.2
Potatoes, Early	50	60.0
Potatoes, Late	100	20.0
Potatoes, (Sod) Late	12.5	19.0
Pumpkins	100	65.0
Radishes	50	21.2
Squash	12.5	24.6
Tomatoes	100	50.6
Turnips	12.5	29.0

The average increase of the foregoing thirty crops is 38.26 per cent. in favor of the radium-treated plots.

Altogether, it is fair to assume that the results on this large farm approached more nearly those to be expected in ordinary agricultural operations than did those at Nutley.

NOTES AND COMMENTS

Radium bromide and Radium carbonate have been accepted by the Council of Pharmacy and Chemistry of the American Medical Association for inclusion in "New and Non-official Remedies." Journal American Med. Assn., Dec. 26th, 1914; p. 2289. The following description of these preparations is given: "Radium Bromide.—Ra Br_2—The anhydrous radium salt of hydrobromic acid."

"It is supplied in the form of a mixture of radium bromide and barium bromide for use in applicators, inhalatoriums, and injection solutions and is sold on the basis of its radium content."

"Pure anhydrous radium bromide, containing 58.6 per cent. of radium (Ra) is a white or slightly brownish crystalline substance, soluble in water."

Radium Carbonate.—Ra C O_3—The anhydrous radium salt of carbonic acid.—The market supply is usually a mixture of radium carbonate and barium carbonate and is sold on the basis of its radium content."

"Non-Proprietary Preparation:

"Radium Carbonate, Standard Chemical Co.—It is supplied in the form of a mixture of radium carbonate and barium carbonate for use in applicators. It is sold on the basis of its radium content."

"Manufactured by the Standard Chemical Co., Pittsburgh, Pa. (Radium Chemical Co., Pittsburgh, Pa.)."

"Pure radium carbonate, containing 79.0 per cent radium (Ra), is a white or slightly brownish salt insoluble in water, decomposed by acids."

"No gases are given off spontaneously from anhydrous radium carbonate by reason of the decomposing action of the radiations, as is the case with the chloride and bromide."

"The presence of radium can be demonstrated qualitatively by electroscopic or by photographic methods."

"The quantitative determination of radium is carried out according to the method *Rutherford* and *Boltwood* (*Rutherford's* "Radio-Active Substances and their Radiations").

We supply

RADIUM

In the form of

RADIUM BROMIDE RADIUM SULFATE

RADIUM CHLORIDE RADIUM CARBONATE

Radium Element content guaranteed

All Standard designs of Applicators

Radium Chemical Company

General Offices and Laboratories

Forbes and Meyran Avenues Pittsburgh, Pa.

Radium Chloride, Radium Bromide, Radium Sulfate and Radium Carbonate (Standard Chemical Co.) have been accepted by the Council on Pharmacy and Chemistry of the American Medical Association.

STANDARD CHEMICAL COMPANY

PITTSBURGH, PA.

CARNOTITE ORE

Miners of Uranium and Vanadium Ores, and Producers of Radium

STANDARD CHEMICAL COMPANY

BLETCHER-ANCHORS CO. PRINTERS, PGH.